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## COMMUNICATION INFRASTRUCTURE AND METHOD TO SPEED UPLINK DATA SETUP

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### Field of the Invention

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The present invention relates generally to the field of wireless communication and, in particular, to reducing the time required to setup uplink data connections.

### Background of the Invention

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In today's General Packet Radio Systems (GPRS) a packet control unit (PCU) manages, allocates, and schedules the use of packet data resources necessary to establish uplink packet data connections between mobile units and the infrastructure. To reduce the cost of deploying these systems, PCUs are remotely located from the basestation transceiver systems (BTSs) that maintain the wireless links between the mobile units and the infrastructure. When a mobile unit requests an uplink data connection the BTS maintaining the wireless link with the mobile must communicate with the remote PCU to setup the requested link. Thus, the link setup is delayed by the messaging between the BTS and the PCU. Because of uplink messaging required by the internet protocol (IP), this BTS-PCU delay may be experienced multiple times while a web page is downloaded to the mobile. Therefore, to speed overall data transfer a

need exists for a communication infrastructure and method to speed uplink data setup.

### Brief Description of the Drawings

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FIG. 1 is a logical, block diagram depiction of a communication system in accordance with a preferred embodiment of the present invention.

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FIG. 2 is a logic flow diagram of steps executed by a PCU in accordance with a preferred embodiment of the present invention.

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FIG. 3 is a logic flow diagram of steps executed by a BTS in accordance with a preferred embodiment of the present invention.

### Description of a Preferred Embodiment

To address the need for a communication infrastructure and method to speed uplink data setup, the present invention provides for the assignment of uplink packet data resources by BTSs without the need to communicate with any PCUs first. The present invention accomplishes this by reserving packet data resources before they are needed or requested and providing them to BTSs for assignment. Thus, BTS-PCU communication occurs in the period before an uplink connection is needed and after uplink data is established, effectively eliminating the BTS-PCU delay from uplink data setup. Moreover, the present invention provides for the transmission of transmit allowance messages before an uplink request is made by the communication unit, further reducing uplink data setup time.

The present invention can be more fully understood with reference to FIGs. 1-3. FIG. 1 is a logical, block diagram depiction of a communication system in accordance with the preferred embodiment of the present invention. Preferably, communication system 100 is a system in accordance with the well-known European Telecommunications Standards Institute – 3<sup>rd</sup> Generation Partnership Project - Digital Cellular Telecommunications System - General Packet Radio Service standard (herein referred to as “GPRS”).

System 100 comprises communication infrastructure 101, communication unit 102, and the Internet (or private intranet) 120. Communication infrastructure 101 comprises BTS 106, base site controller (BSC) 108, PCU 110, and GPRS support node (GSN) 112. BTSs, BSCs, PCUs, and GSNs are well known in the field of wireless communications and are described in the GPRS standard. Thus, BTS 106 and PCU 110 are well known GPRS devices modified using well-known software techniques to perform the present invention. Communication unit 102 preferably comprises a wireless mobile unit that communicates with infrastructure 101, specifically BTS 106, via wireless communication resource 104 in accordance with the GPRS standard. In general, GPRS communication units vary with respect to the time slots each can use while communicating with the infrastructure. Communication unit 102, also therefore, has a so-called timeslot configuration that determines which time slots it can use.

Operation of a preferred communication system, in accordance with the present invention, occurs substantially as follows. In its most fundamental embodiment, PCU 110 of the present invention reserves packet data resources needed for an uplink connection from communication unit 102 to communication infrastructure 101. PCU 110 reserves the resources before communication unit 102 needs or requests the uplink connection, and sends to BTS 106 a message identifying the packet data resources reserved. Preferably, the resources reserved

include a subchannel of an available packet data channel, a timing advance index (i.e., a GPRS TAI), and a temporary flow identifier (i.e., a GPRS TFI). PCU 110 also transmits via BTS 106 an uplink transmit allowance message (i.e., a GPRS uplink state flag or USF) for the packet data subchannel. The uplink transmit allowance message is needed by communication unit 102 to transmit on the uplink subchannel (i.e., after being assigned to the subchannel).

BTS 106 receives from communication unit 102 via wireless communication resource 104 a request for an uplink connection (i.e., a GPRS random access channel request). BTS 106, having earlier received a message identifying the packet data resources reserved, assigns the reserved resources to communication unit 102 and preferably sends communication unit 102 a GPRS Immediate Assignment message identifying the packet data resources assigned. In the preferred embodiment, BTS 106 then sends PCU 110 an indication that the packet data resources reserved have been assigned.

To simplify the description above, PCU 110 was described as reserving packet data resources needed for a single uplink connection. Preferably, however, PCU 110 determines the number of packet data resources to reserve (i.e., the number of uplink connections to reserve resources for) based on a rate of indications that packet data resources reserved have been used to establish uplink connections. In other words, the rate of uplink establishment is used as an indicator of demand for uplinks. The greater the calculated demand, the more resources are reserved in anticipation. Preferably, each set of resources for an uplink is handled as the single set of resources was handled in the description above. In addition, packet data resources usable by the greatest number of communication units are reserved first. The various time slot configurations of the communication units supported by the system determine which resources will be usable by the greatest number of communication units.

Regarding the transmission of the uplink transmit allowance messages, preferably, PCU 110 repeatedly transmits allowance messages. For packet data resources on packet data channels that continuously transmit (e.g., on broadcast carriers or BCHs), PCU 110 repeatedly transmits allowance messages for each set of resources reserved based on the relative order of reservation of each of the corresponding sets of resources. (For packet data resources on packet data channels that do not continuously transmit, PCU 110 may not transmit the corresponding allowance messages until PCU 110 receives an indication from BTS that the packet data resources reserved have been assigned.) The relative order of reservation determines the frequency of each repeated transmission of the allowance message for that set of reserved resources. For example, the uplink transmit allowance message for the first set of resources reserved will be transmitted most frequently, while messages for subsequent sets transmitted less and less frequently, if at all. Because communication units must receive the transmit allowance message for their assigned subchannel before transmitting data, the allowance messages are preferably transmitted repeatedly and with a frequency related to the likelihood that a communication unit has already received an assignment for the corresponding subchannel and is waiting to transmit data. The preferred embodiment thus seeks to minimize the uplink data setup delay.

FIG. 2 is a logic flow diagram 200 of steps executed by a PCU in accordance with a preferred embodiment of the present invention. The logic flow begins (201) with the PCU determining (202) the number of packet data resources to reserve for uplink connections. As discussed above, an estimation of demand for uplinks and the particular communication unit timeslot configurations supported are used for this determination. The PCU then reserves (203) packet data resources needed for the number of uplink connections determined and sends (204) messages identifying the packet data resources reserved to a BTS.

In step 205, the PCU repeatedly transmits, in the manner discussed above, uplink transmit allowance messages for the uplinks for which resources are reserved. In the preferred embodiment, as reserved resources are assigned by the BTS, the PCU receives (206) an indication  
 5 that the particular resources reserved are assigned to establish uplink connections, and the logic flow ends (207). Preferably, this indication may either be a message from the BTS indicating that the BTS assigned the packet data resources to the communication unit or data received from a communication unit via the uplink connection itself. Also, this indication of  
 10 reserved resources being assigned preferably triggers a new determination as in step 202. If communication unit demand for uplink connections is above a threshold, the PCU again reserves resources for uplink connections repeating the logic flow of diagram 200.

FIG. 3 is a logic flow diagram 300 of steps executed by a BTS in  
 15 accordance with a preferred embodiment of the present invention. The logic flow begins (301) with the BTS receiving (302) a message identifying packet data resources reserved by the PCU. The BTS also receives (303) a request for an uplink connection from a communication unit. In the interim between steps 302 and 303, the BTS may receive multiple  
 20 messages identifying packet data resources reserved by the PCU. Upon receiving a request for an uplink connection, the BTS assigns (304) a set of reserved resources to the requesting communication unit for the establishment of an uplink and transmits (305) an assignment message identifying the packet data resources assigned to the communication unit.  
 25 Preferably, the BTS assigns resources for uplinks in the same order it receives them from the PCU, unless the PCU sends the BTS a cancel message, canceling the reservation of particular packet data resources. After assigning resources, the BTS preferably sends (306) the PCU an indication of which packet data resources have been assigned, and the  
 30 logic flow ends (307).

The present invention thus speeds overall data transfer by reducing the time required to setup uplink data connections. PCUs and BTSs no longer must exchange messages between the communication unit request for an uplink and the assignment of an uplink. Furthermore, the present invention provides for the transmission of transmit allowance messages before an uplink request is made by the communication unit. This reduces the time the unit must wait for the transmit allowance once assigned an uplink. Together, these aspects of the present invention significantly speed uplink data setup.

While the present invention has been particularly shown and described with reference to particular embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention.

What is claimed is: